THE INTEGRATED PEST MANAGEMENT MODEL AS QUALITY INFORMATION SYSTEM FOR THE MEDITERRANEAN ECOSYSTEMS

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Abstract

Integrated expert systems are computer programs that are used through the principles of quality information systems to simulate the problem of cotton crop management and coordination, in an irrigated area of 300 Km² in Thiva region (Biotia, Greece). This study describes, by some graphics, a crop simulation model of production and the ecosystem management, in order to give more ecologically balanced pest control alternative practices and gradually reduce pesticide use in Mediterranean agriculture.

Résumé

Les systemes intégrés sont des programmes pour ordinateur, utilisés à travers les principes du système informatique de qualité, visant à simuler le problème de gestion et de coordination d'une culture de coton, dans une aire irriguée de 300 Km² de la Région de Thiva (Biotia, Grèce). L'étude écrit, à l'aide de quelques graphiques, un modèle de simulation de la production d'une culture et la gestion de l'écosystème, de sort à établir des pratiques plus équitables de lutte contre les parasites, qui réduisent l'utilisation des pesticides dans l'agriculture Méditerranéenne.

The Mediterranean ecosystems could be characterized by the quality activities of Regional Development with *sporadic* and *chronic* problems.

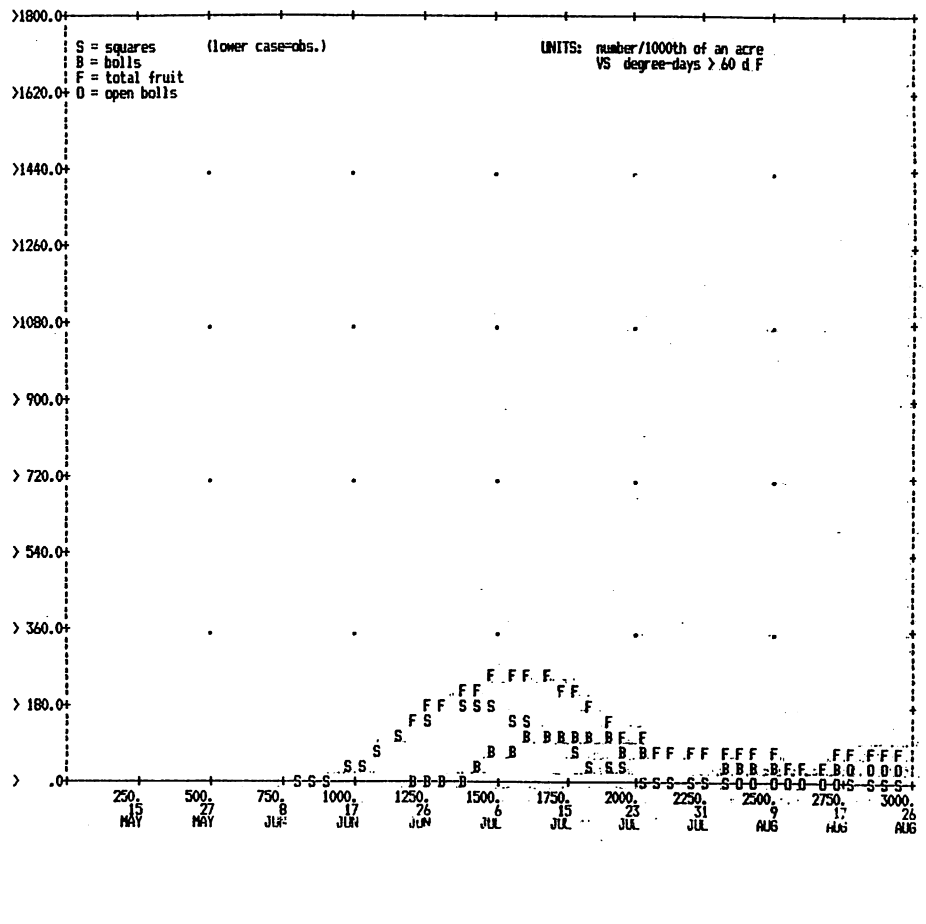
A sporadic ecosystem problem is a sudden adverse change in the status quo, requiring remedy through restoring the status quo. A chronic ecosystem problem is a longstanding adverse situation, requiring remedy through changing the status quo. The danger is that the firefithting on sporadic problems may take continuing priority over effort where larger savings possible, i.e. chronic problem.

The difference between the historic and the optimum level with the use of natural resources on the basin of Mediterranean countries is a chronic Environmental problem. (J.M. Juran, F.M. Gryna, Jr. 1980). Chronic problems require a far reaching investigation. If the solution was easy the problem would not be chronic. The size of a chronic ecosystem problem as a qduality study, considering competition between countries or organization mechanismes, requires a simulation model with the following basic principles:

1. Definition of the output variables
2. Definition of the input variables
3. Description of the complete system relating to the input and output variables
4. Data on the distribution of each input variable. This variability is accepted as inherent of the process.

The Mediterrranean ecosystem of a regional cotton cultural area and the above characteristics of the simulation model could be introduced with an IPM model with the following management functions:

1. *Record keeping* by the use of spreadsheet format for recording, storing and retrieving field data.
2. *Weather monitoring* from the weather database using a model of communication program provided.
3. *Agronomic management* with recommendations for irrigation, fertilization, seeding, crop termination and growth regulator applications.
4. *Pest management* using your monitoring data and background information, for guidelines evaluating the deseases-insects treatments recommendations.
5. *Crop Simulation model* predicts development of the crop, giving estimates of



Graph 1 - Fruit pattern - Field: Thiva, Aug. 07 6:51 pm

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Table I ***Cotton crop simulation model. Field: Thiva - Date: Aug. 07, 1991 6:51 pm.***

Conditions For Run

Date: Aug 7
Last RPT Irrig: none

Weather Data: to Dec 31
Square Size Counted: 6

Field observations

	Crop	Lygys	Baw	Mites
Number	0	0	0	0
Last Date	none	none	none	none

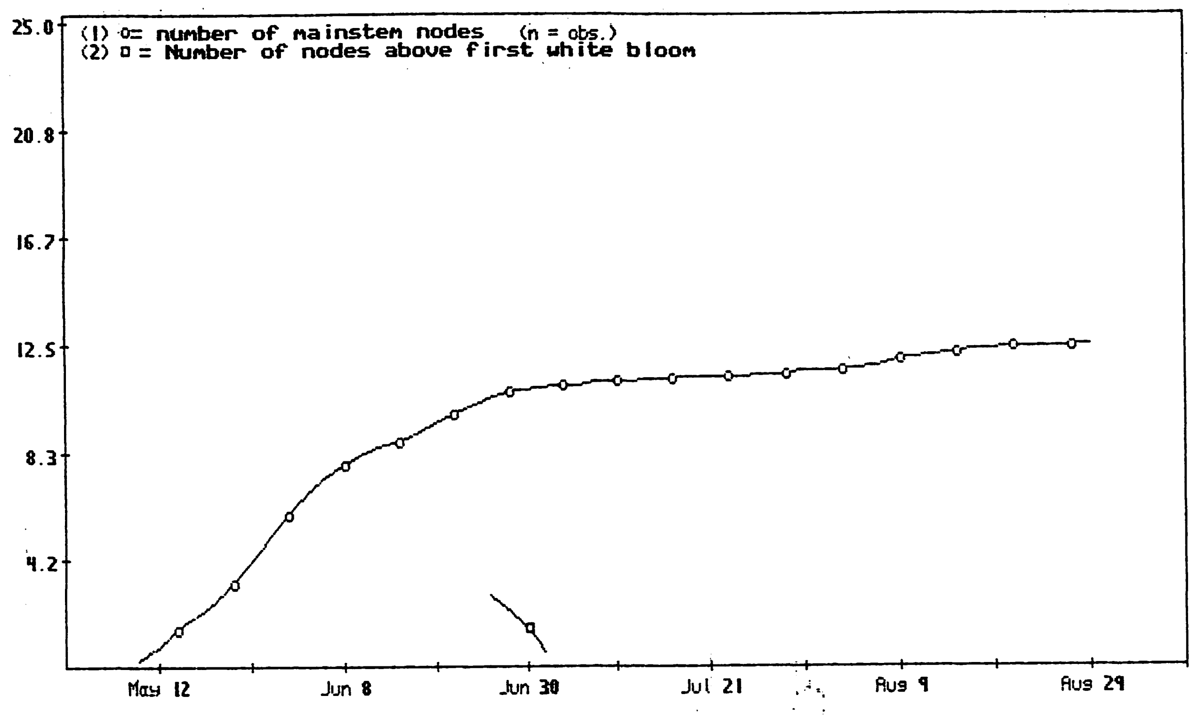
Simulation projections

1st Sq	1st Boll	Peak Sqr
Jun 11	Jun 26	Jul 1

Suggested Defoliation
Aug 21 at 73% Open Bolls

Suggested harvest
Sept 4 at 97% Open Bolls

Yield
.5 Bales/Acre
248.8 Pounds/Acre
62.3 Open Bolls/1000th Acre



Grapb 2 - Mainstem nodes.

maturity, yield and pest damage.
6. *Testing management alternatives* by entering hypothetical data.

The crop ecosytem simulation model

Basic and applied ecologists have become interested in first step by landscapes because enviromental problems may occur at large scales.
Landscapes also provide a context to understand the role of ecosystems and has been considered by the international society. Thus, it appears as if lanscape ecology is a model, in the sense of *Kuhn*, which is in an early stage of development.
The cotton model simulates a season growth of the ecosystem cotton crop as dynamic analysis model, at first the performance of it as whole.
The rate of crop maturity, seasonal pattern for numbers of bolls, square mainstem nodes and nodes above the highest white bloom on a plant fore casts the yieldper acre as process-oriented (physiologically-based). It combines information cotton growth system as affected by temperature, solar radia-

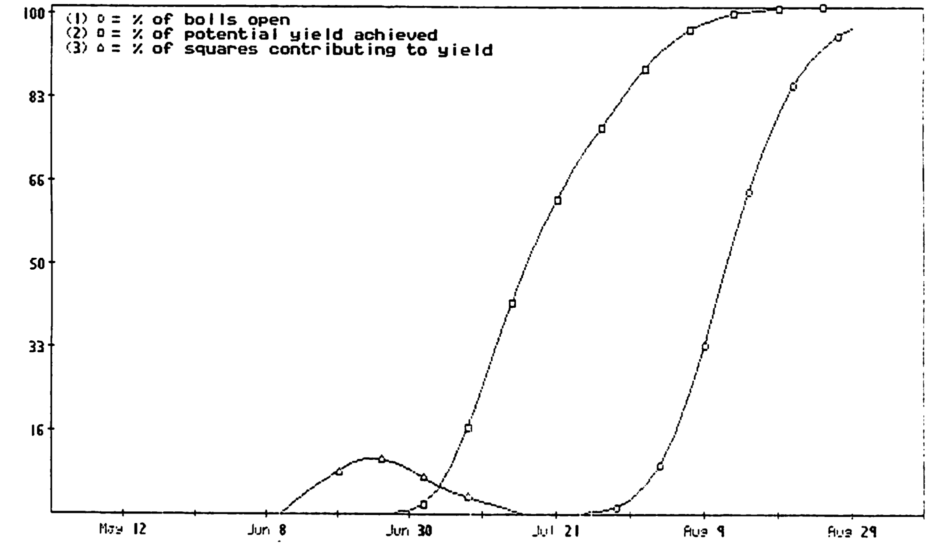
Table II ***Leaf water potential. Field: Thiva - Date: Aug. 07, 1991 6:51 pm.***

Date	Degree-days	Last Irrig	LWP	Percent Photosyn
May 4	94.0	Planting	– 10.1	99
May 8	141.9	Planting	– 10.2	99
May 11	193.7	Planting	– 10.3	98
May 14	247.3	Planting	– 10,4	98
May 17	301.8	Planting	– 10.5	97
May 20	357.3	Planting	– 10.6	97
May 23	414.6	Planting	– 10.6	97
May 25	469.3	Planting	– 10.6	97
May 28	520.5	Planting	– 10.6	97
May 31	575.0	Planting	– 10.5	97
Jun 2	632.8	Planting	– 10.5	98
Jun 5	687.9	Planting	– 10.5	98
Jun 7	744.0	Planting	– 10.5	98
Jun 10	800.7	Planting	– 10.5	98
Jun 12	859.9	Planting	– 10.5	97
Jun 14	919.2	Planting	– 10.5	97
Jun 16	979.3	Planting	– 10.6	97
Jun 18	1036.8	Planting	– 10.7	97
Jun 21	1093.5	Planting	– 10,9	96
Jun 23	1151.7	Planting	– 11.0	96
Jun 25	1209.5	Planting	– 11.1	95
Jun 27	1266.6	Planting	– 11.3	94
Jun 29	1323.9	Planting	– 11.4	94
Jul 1	1380.2	Planting	– 11.6	93
Jul 4	1439.2	Planting	– 11.9	92
Jul 6	1498.8	Planting	– 12.2	91
Jul 8	1556.1	Planting	– 12.5	90
Jul 10	1613.3	Planting	– 12.8	88
Jul 12	1675.1	Planting	– 13.1	87
Jul 14	1734.5	Planting	– 13.4	86
Jul 16	1791.0	Planting	– 13.8	84
Jul 18	1846.5	Planting	– 14.2	83
Jul 20	1909.1	Planting	– 14.6	81
Jul 22	1969.1	Planting	– 15.0	79
Jul 24	2028.7	Planting	– 15.5	78
Jul 26	2088.5	Planting	– 15.9	76
Jul 28	2149.4	Planting	– 16.5	74
Jul 30	2207.5	Planting	– 17.0	71
Aug 1	2265.0	Planting	– 17.6	69
Aug 3	2325.9	Planting	– 18.1	67
Aug 5	2385.3	Planting	– 18.6	65
Aug 7	2443.3	Aug 7	– 19.2	63
Aug 9	2503.2	Aug 7	– 10.1	99
Aug 11	2562.3	Aug 7	– 10.2	99
Aug 13	2621.2	Aug 7	– 10.4	98
Aug 15	2677.7	Aug 7	– 10.5	98
Aug 17	2737.6	Aug 7	– 10.6	97
Aug 19	2797.7	Aug 7	– 10.7	97
Aug 21	2855.9	Aug 7	– 10.8	96
Aug 23	2913.9	Aug 7	– 10.8	96
Aug 25	2970.8	Aug 7	– 10.9	96
Aug 27	3030.0	Aug 7	– 11.0	96
Aug 29	3089.9	Aug 7	– 11.0	95
Aug 31	3147.6	Aug 7	– 11.0	95
Sep 2	3202.9	Aug 7	– 11.1	95

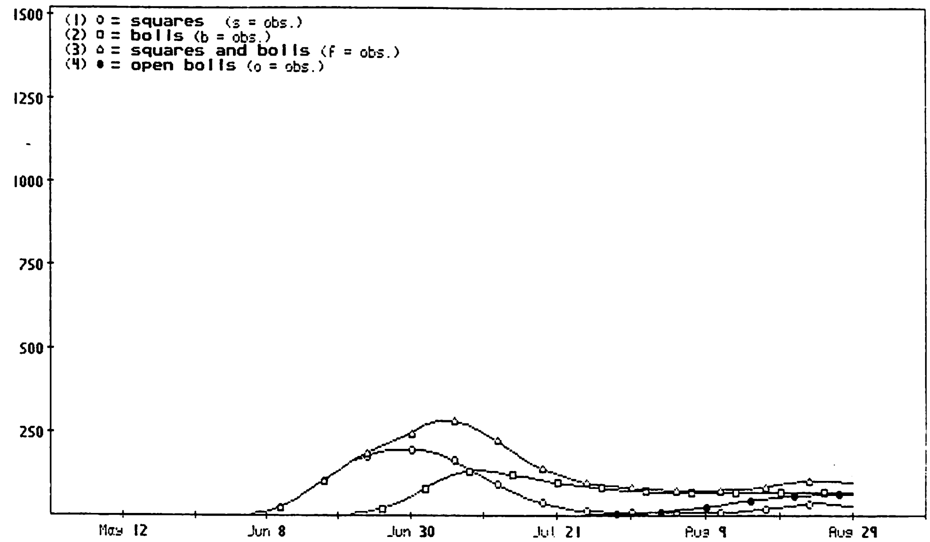
tion, water and nitrogen stress, and pest damage (**Table II**).
A key element in the structure of the model is the ability to *«self-correct» based on the field observations of growth parameters as output variables*. For example if the crop model simulates more mainstem nodes than are actually present in a field, the model adjusts the phytosynthesis rate and related numbers of fruits, leaves, stems, and roots, to reflect the field observations.
The crop simulation model is particularly useful for predicting the timing of crop development. The greater amount of accurate information provided when running the simulation model, the better will the model predict the crops phenology and resulting yield. Although the crop and pest models are intented to be useful information when utilized in this manner, likewise evaluate the effect of different irrigation schedules or of different timing of pesticides applications.
Three separate pest simulation models have been developed as part of the cotton integrated Expert system. All three pest models are physiologically-based and are linked to the crop system model. All three pest models of *the «spider mite», «lygus bug»* and *«beet armyworm»* predict seasonal patters of eggs, nymphs and adults. These models estimate the amount of the present damage and expected damage through the end of the season and forecast the population of the pests the same time. (**Graphs 5, 6**).
The pest models interact with the crop model by simulating the damage by leaf-feeding insects (estimating the effect on photosynthesis) and by fruit feeders and the resulting effect on fruit retention and yield. Every time the plant data spreadsheets are updated, update your pest data spreadsheets. This will ensure that the damage effect of these pests is acounted for.
Use of the model: It will forecast (**Table I**)
1. First square, first boll and peak square
2. Recommended defoliation date
3. Recommended harvest date
4. Yield
5. Number of open bolls at harvest.

It will generate graphs of (Graphs)
1. Squares and bolls through the season
2. Number of mainstem nodes and the number of nodes above
3. Rate of boll opening
4. Contribution of squares on the plant at any time to yield
5. Pest populations.

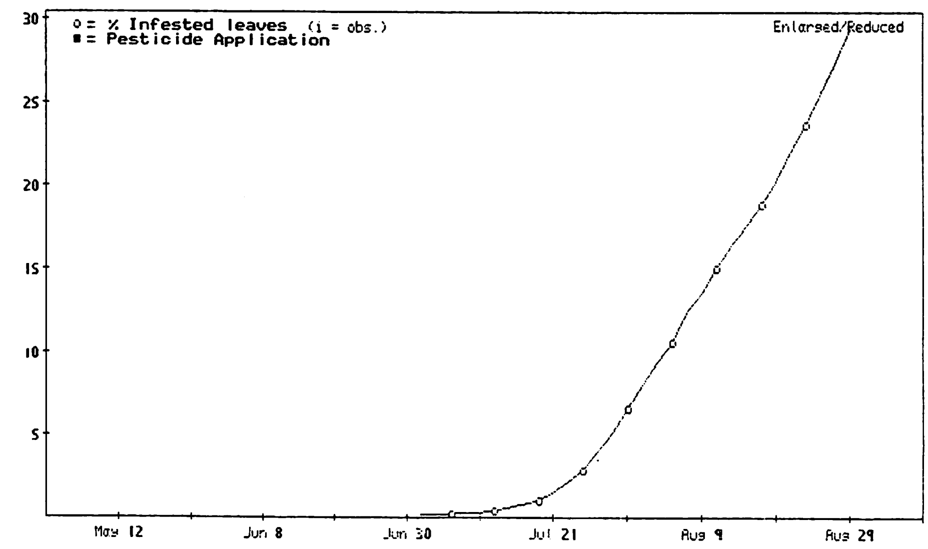
Since the graphs are divided into field informations as definition of input variables, it is relatively simple to select a sample of fields in different locations to represent different soils, climate and topographical positions in the countries of Mediterranean basin. The productivity of the fields is differed between the locations of the countries as well as between fields (**Graphs 1, 2, 3, 4**).



Graph 3 - Yield.



Graph 4 - Squares and bolls.



Graph 5 - Spider mites.

Table III | ***Cotton 3.2.***

Report for Thiva on 5/30
Weather file: Thiva — Weather updated through: 21/31/91
Days since planting (4/24): 36
Degree-days (>60F) since planting: 551
30 year average degree-days (>60F) since planting: 315

Spider mites

Action	Date	Based on
Scout	5/30	DD/data Check

Lygus bugs (v. 900314)

Date	% Damaged or missing squares	Pesticide code

No data

Action	Date	Based on
Scout	5/30	Square damage

Irrigation (v. 900314)
(*) Note: Totals listed below do not include preseason irrigations that may have been applied.
(**) See «explain reason» option.

Action	Date	Amount	Based on
Irrigation	7/4	2.5 in/ac	first via table
Irrigation	9/9	5.0 in/ac	last via table
Recommended total		7.5 in/ac	season schedule
Total applied		0.0 in/ac	applied to date

Crop termination
Need 3 values for node above bloom beteween 9 and 3.

Action	Date	Based on
Sample	5/30	Date/data check

Soil fertility (v. 900314)

Date	Lbs. nitrogen applied	Nitrogen method code	Nitrogen type code

No data

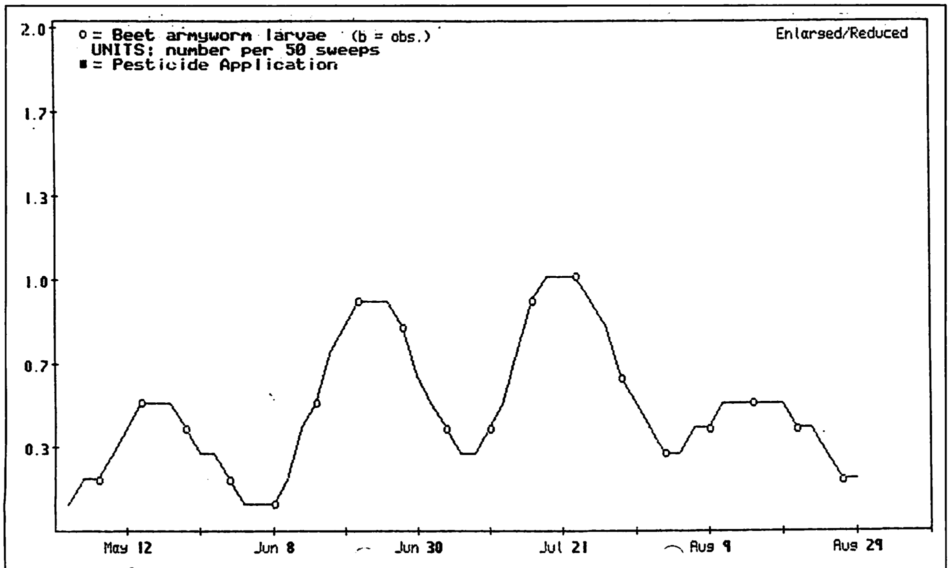
Action	Based on
No nitrogen needed	Soil N

Plant vigor (v. 900314)

Date	Mainstem nodes	Plant height

No data

Plant height and/or mainstem node counts needed.



Graph 6 - Beet armyworm.

Conclusion

The ecosystem plant-insects in crop model analysis was used to interpret energy and matter flows. The ecosystem as chronic quality problem needs a similar integrated management program in order to provide reliable quality control as a network between the Mediterranean countries, working in a range of crops and education-economic policy situations. In many cases, policy and economic constrains will have to be removed in order to foster the widespread use of these less-toxic alternatives. In the growers community the critical needs of these issues are the *Ecosystem Management Information*, in the marketing systems througtout Mediterranean countries are the *Comparative Studies of Ecosystem Management Alternatives* and the *Research-Analysis of Various Policies* for «crop insurrance» including registration procedures and the licensies of professional controls.

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